

**A gossypure
product that lasts!**

DISRUPT

**Pink Bollworm Flakes
from HERCON®**

Suppresses worm populations
Reduces cotton boll damage
Protects beneficial insects



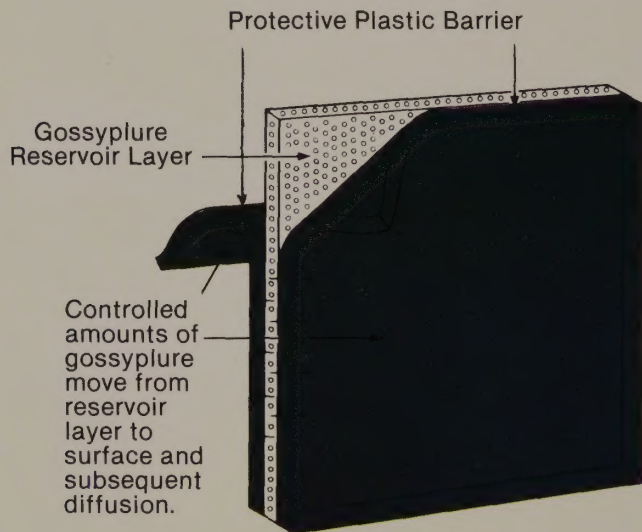
Division of
HEALTH-CHEM CORPORATION

Q&A

What is HERCON® DISRUPT® PBW?

DISRUPT Pink Bollworm (PBW) flakes are small, aerially applied, multi-layered plastic "sandwiches" that emit gossyplure, the sex pheromone of the pink bollworm, *Pectinophora gossypiella*, at a controlled rate, over an extended period of time.

The Hercon® Disrupt® Gossyplure Flake



How does DISRUPT PBW work?

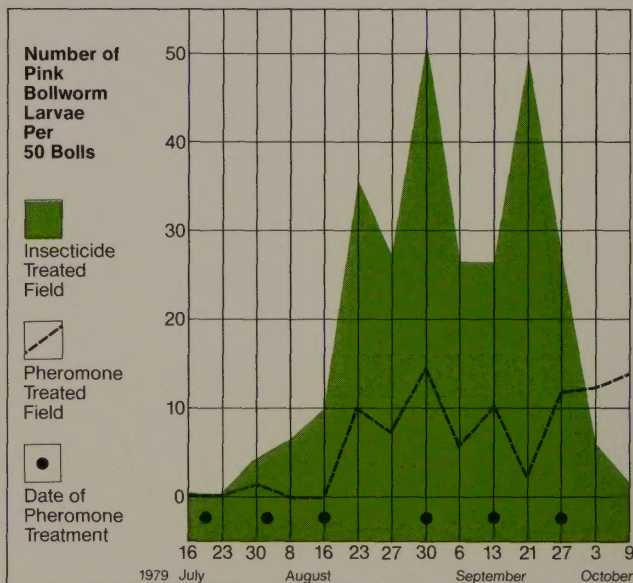
DISRUPT PBW flakes are broadcast in the field from special applicators mounted on agricultural aircraft. The flakes release the pheromone into the "mating zone" of the crop (upper canopy) where adult pink bollworm moths are searching for sexually receptive females with which to mate. Permeating the "mating zone" with the synthetic sex pheromone results in males chasing "artificial" females but rarely locating a real female ready to mate.



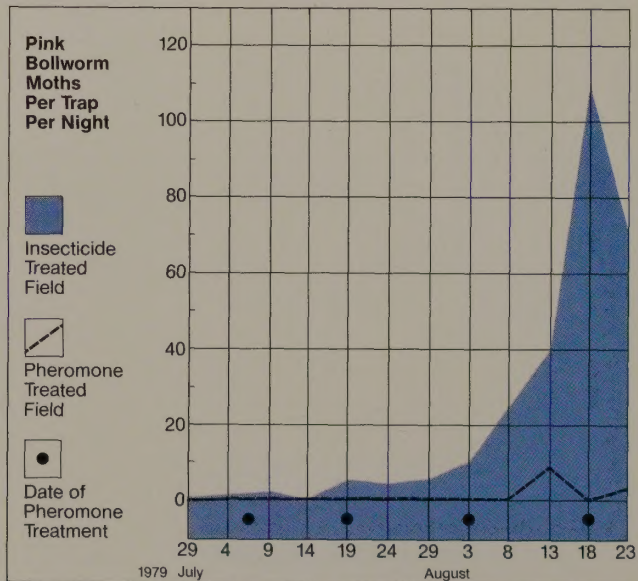
How does DISRUPT PBW help protect the cotton crop from damage?

Preventing most of the female pink bollworm moths in a given field from mating greatly reduces the number of damaging larval offspring produced by that generation. Thus, the development, from generation to generation, of economically damaging infestations of pink bollworm is delayed or prevented. Furthermore, since gossyplure's effect is specific on the pink bollworm, beneficial insects in the field will not be harmed.

Pink bollworm damage



The effect of gossyplure on pink bollworm moth infestations



What is the application rate of DISRUPT PBW?

DISRUPT PBW is applied at an average rate of 60 grams of flakes per acre. The EPA registered label allows an application of 1.5 to 2.0 grams actual gossypure per acre. DISRUPT PBW flakes are conveniently packaged in 1.3-lb and 2.6-lb bags sufficient to treat 10 acres and 20 acres, respectively. When DISRUPT PBW is applied at recommended rates, there will be 10,000 to 13,000 flakes, or pheromone point sources, applied per acre. The flakes can be readily observed on the upper canopy of the crop.

What equipment is used to apply DISRUPT PBW?

Hercon's special aerial application equipment, developed in conjunction with Schweizer Aircraft Corporation, makers of the Ag Cat, is used to apply sticker-coated DISRUPT PBW flakes. This unique equipment eliminates the time consuming, expensive and messy manual pre-mixing of flakes and sticker before treatment. The Hercon applicator automatically mixes the DISRUPT PBW flakes and PHERO-TACTM sticker internally. Both materials are metered independently.



**The Hercon/Schweizer
Aerial Applicator**

What is PHERO-TAC?

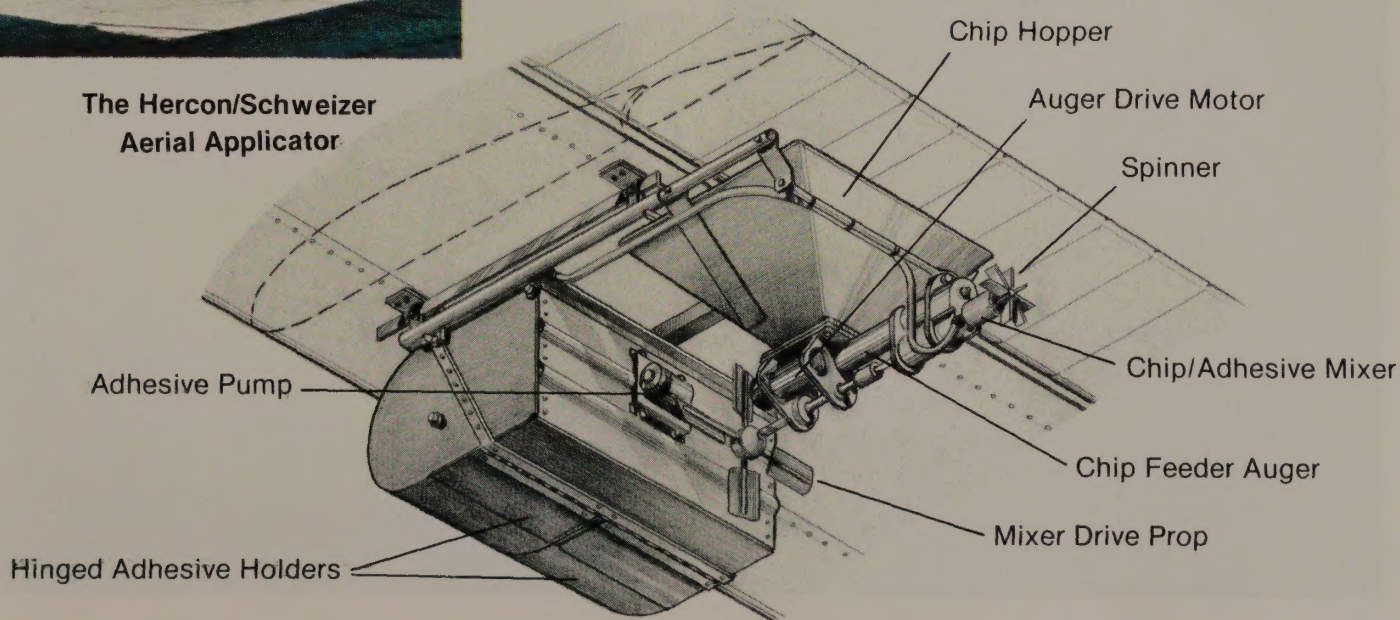
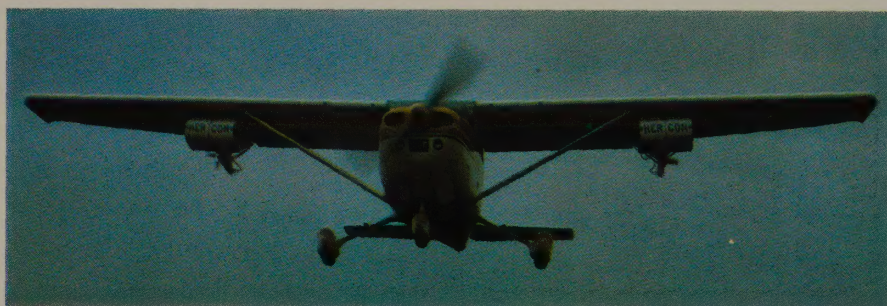
PHERO-TAC is an inert adhesive specially formulated for use with DISRUPT PBW flakes. PHERO-TAC allows the flakes to cling to foliage in the insect mating zone providing visual confirmation of uniform flake coverage.

What controls the application rate of the DISRUPT flakes?

Precision electronic controls are used. These controls are pre-set to accommodate aircraft type and desired speed. Once set, only a periodic check is required. At normal distribution rate, 250 to 300 acres can be treated per mission. Ground or "down" time is approximately 7 to 10 minutes. A recommended 50 foot swath will provide even DISRUPT PBW flake distribution over large areas quickly and economically.

Is applicator clean-up after spraying required?

Only minimal clean-up is required, but, it is recommended that unused DISRUPT PBW and PHERO-TAC materials be removed from the applicator and stored properly for future use. The Hercon DISRUPT PBW applicator was designed for fast and easy use by ag-operators.



When is the first application of DISRUPT PBW recommended?

Mating disruption programs may be initiated at the time of, or shortly before, cotton plants produce the first squares, i.e., pin-square stage of plant growth. Maximum population suppression is often achieved from programs started at pin-square. However, fewer pheromone applications will provide good population suppression in certain fields, e.g., first year cotton, late planted fields, and fields with low overwintering populations, when disruption of the first generation moths is the target of the initial application. In such a delayed program, DISRUPT PBW should be applied during the *first* week of blooming in the field. The first application of DISRUPT PBW must be made before the development of the first small bolls, regardless of cropping history or pink bollworm overwintering density.

What is the re-treatment interval with DISRUPT PBW?

DISRUPT PBW applications are effective for approximately 3 weeks when daily field temperatures are below 100°F. When daily maximum temperatures are greater than 100°F, subsequent applications are needed at 14-day intervals. Extremely high desert temperatures may necessitate re-treatment at 10 to 12-day intervals during the hottest summer months.

Pink Bollworm Moth Attracted to PBW DISRUPT® Flake



How is DISRUPT PBW monitored for effectiveness?

From the time first susceptible bolls are present in program fields, collect and examine at least weekly (preferably twice weekly) 14-to-21-day old boll samples for pink bollworm larvae. Consult your local Agricultural Extension Service for recommended boll sampling procedures.

Traps baited with Hercon LURETAPE® with gossyplure dispensers may also be used to monitor overwintering moth emergence cycles, population density and effectiveness of DISRUPT PBW applications. Although a few moths will occasionally be trapped in DISRUPT PBW treated fields, a relatively high moth capture soon after treatment may indicate poor coverage or other treatment problems. Trap counts will usually increase as the amount of gossyplure in the mating zone and disruption of mating decreases to a certain threshold.

Pink Bollworm Monitoring Trap



What is HERCON® LURETAPE®?

LURETAPE is a Hercon controlled release pheromone dispenser designed for manual application. LURETAPE gossyplure dispensers are used in monitoring programs for the pink bollworm. LURETAPE containing other pheromones are also used for the disruption of mating of various target insects and as baits in mass trapping programs.

When should DISRUPT PBW mating disruption program be terminated?

If regular field monitoring and verification from additional boll samples indicate that the population of small larvae in bolls is exceeding the local economic threshold, consideration should be given to application of an insecticide. When field edges or 'hot spots' of pink bollworms are detected, spot treatment with insecticide is recommended to kill mated moths but leave a supply of beneficial insect predators and parasites throughout the remainder of the field. Continuation of the DISRUPT PBW pheromone program is recommended except when the infestation remains above the economic threshold and additional insecticide treatments are required. If cotton bollworm/tobacco budworm, cotton leafperforator or other pests require regular insecticide treatments the DISRUPT PBW program should be terminated since pink bollworm moths will also be killed by the insecticide.



How does Hercon quality control affect DISRUPT PBW field performance?

Hercon's stringent quality control procedures and the patented Hercon® controlled release system contribute to the consistency, reliability and long lasting performance of DISRUPT flakes in cotton fields. Quality control procedures are implemented from the time raw materials are received. They are rigidly observed for each individual manufacturing stage through to the finished, ready-to-deliver product. DISRUPT PBW is tested constantly by Hercon Quality Control Technicians to ensure that all critical performance factors such as product uniformity, flake size, and gossyplure concentration comply with product specifications. Hercon's proprietary production/inspection systems serve to detect the presence of inhibitory chemicals, prevent the loss and degradation of gossyplure when in storage, and eliminate the need for volatile and inflammable solvents such as hexane. Before receiving their final stamp of approval, DISRUPT PBW flakes must conform to the established product performance levels and must meet or exceed all Hercon quality standards.



Pink Bollworm in Flower (Above)
Pink Bollworm Feeding (Top left)
DISRUPT® PBW Flakes (Bottom left)

The Predators

It is important to note that beneficial insects can be effective in the management and control of pest species. Also known as predators, they are the natural enemies of certain insects.

DISRUPT PINK BOLLWORM FLAKES WITH GOSSYPLURE, BEING SPECIFIC TO THE PINK BOLLWORM, WILL NOT HARM BENEFICIAL INSECTS.

A partial listing of beneficial insects.



Assassin Bugs



**Minute Pirate Bugs
(Insidious Flower Bugs)**



Big-Eyed Bugs



Nabid or Damsel Bugs



Collops Beetles



Six-Spotted Thrips



Green Lacewings



Spined Soldier Bugs



Lady Beetles



Spiders

FROM HEALTH-CHEM

HERCON[®] DISRUPT PBW[®] WITH GOSSYPLURE

MATING DISRUPTANT AND POPULATION SUPPRESSANT

HERCON DISRUPT PINK BOLLWORM is a controlled release pheromone (gossyplure) dispenser formulation designed to lower incidence of mating of adult pink bollworm moths, *Pectinophora gossypiella*, by disrupting normal male orientation to female moths. This reduction in mating will subsequently reduce pink bollworm damage in cotton due to a suppressed larval (worm) population. Use of DISRUPT PINK BOLLWORM may reduce the risk of aflatoxin-contaminated seed and delay or decrease the use of conventional insecticides which may be harmful to beneficial parasites and predators, and pollinators.

PRECAUTIONARY STATEMENTS

Hazards to Humans and Domestic Animals

Keep out of reach of children. Do not open protective container until ready to use. No protective equipment needed. Wash hands with soap and water after handling.

Hazards to the Environment

Keep out of lakes, streams, and ponds. Do not contaminate water by cleaning of equipment or disposal of wastes.

STORAGE AND DISPOSAL

Storage: Store in sealed containers in a cool, dry place. Keep partially used containers tightly sealed.

Pesticide

Disposal: Pesticide, spray mixture or rinsate that cannot be used according to label instructions must be disposed of according to Federal, State or local procedures under the Resource Conservation and Recovery Act.

Container

Disposal: Dispose of bags according to approved Federal, State or local procedures under the Resource Conservation and Recovery Act.

Manufacturer's Warranty

HEALTH-CHEM'S HERCON DIVISION warrants that the product, as of the time of its sale by HERCON, conforms to the statements on the label. Except as so warranted the product is sold AS IS.

HERCON makes no other warranty express or implied of fitness or merchantability. In no case shall HERCON be liable for consequential or special or indirect damages resulting from the use of this product. This warranty may be varied only by agreement in writing signed by a duly-authorized representative of HERCON.

FROM HEALTH-CHEM

HERCON[®] DISRUPT[®] PINK BOLLWORM



PINK BOLLWORM MOTH MATING DISRUPTANT

**SUPPRESSES WORM POPULATIONS
REDUCES COTTON BOLL DAMAGE
PROTECTS BENEFICIAL INSECTS**

ACTIVE INGREDIENTS:

(Z, Z)-7, 11-Hexadecadien-1-ol-acetate 1.4%
(Z, E)-7, 11-Hexadecadien-1-ol-acetate 1.4%

INERT INGREDIENTS 97.2%
TOTAL 100.0%

NET WEIGHT: 2.6 lbs (1.2 kg)

**KEEP OUT OF REACH OF CHILDREN
CAUTION**

READ DIRECTIONS AND PRECAUTIONARY STATEMENTS BEFORE USE

FROM HEALTH-CHEM

HERCON[®] DISRUPT[®] PBW WITH GOSSYPLURE

MATING DISRUPTANT AND POPULATION SUPPRESSANT

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

Apply at the rate of 1.5 to 2.0 grams gossyplure pheromone active ingredient per acre per application. This is equivalent to 53.6 to 71.4 grams (or 1.9 to 2.5 ounces) of loosely packed DISRUPT PINK BOLLWORM flakes per acre per application. HERCON PHERO-TAC, an inert sticker, should be used with DISRUPT PINK BOLLWORM to hold the flakes on treated cotton foliage or plant parts. Mix only the amount to be used immediately. The DISRUPT PINK BOLLWORM and sticker mixture should be prepared just prior to aerial or ground application, and according to application machinery requirements and directions. Preferably application should be done only by a qualified person to insure proper rate and method of application.

TIME OF APPLICATION: Using gossyplure-pheromone baited traps (or other suitable means), monitor cotton fields to detect the number of adult pink bollworm moths beginning at planting time. The monitoring program should continue throughout the growing season on a 1- to 3-day schedule to detect population changes.

The first application of DISRUPT PINK BOLLWORM should be made prior to or soon after insect emergence. Plant growth development may be used to determine when to begin DISRUPT PINK BOLLWORM treatments. Each application of DISRUPT PINK BOLLWORM is designed to last an average of 21 days in the field at temperatures of 100°F (37.8°C) or less; at temperatures exceeding 100°F, application intervals should average 14 days. Timing is very important and can vary by geographic location and seasonal conditions. If unsure of local conditions, seek the advice of qualified entomologists or consultants.

Notes: Limiting the use of conventional chemical insecticides will help to maintain the population of predators. This can assist in biological control of other pests and therefore complement pest management.

Manufactured by
HERCON DIVISION
HEALTH-CHEM CORPORATION
1107 Broadway, New York, N.Y. 10010

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**A gossypure
product that lasts!**



**Pink Bollworm Flakes
from HERCON®**

Suppresses worm populations
Reduces cotton boll damage
Protects beneficial insects

A product of



Pheromones . . . Hercon makes them last.

HERCON DIVISION
HEALTH-CHEM CORPORATION
1107 Broadway, New York, N.Y. 10010
212/691-7550

Proposal
to
Screwworm Eradication Program
Animal & Plant Health Inspection Service
and
Screwworm Research, Agriculture Research Service
U. S. Department of Agriculture
Mission, TX 78572

DEVELOPMENT OF SLOW-RELEASE ^{SWASS} ~~SWORMURE~~ PELLETS FOR
SCREWORM SUPPRESSION

Submitted by:

Hercon Division
Health-Chem Corporation
1107 Broadway
New York, N. Y. 10010

Contact: Dr. A. F. Kydonieus 212/691-7550
or Dr. M. Beroza 301/593-2103

Information in this proposal is not to be disclosed
except for evaluation. Restriction does not apply
if contract is awarded or if information is
available from another source.

08/17/83

CONTENTS

Summary

- I. Introduction and objectives
- II. The Hercon® Controlled Release Delivery System
- III. Approaches to the Development of an Improved SWASS Pellet
- IV. Implementation of Proposal
 - A. Outline of proposal
 - B. Specifics of proposal
 - C. Proposed calendar of events
 - D. Cost elements
- V. Key Personnel
- VI. Hercon Expertise and Facilities
- VII. References

Appendix

Resumes of Key Personnel
Publications

SUMMARY

The U. S. Department of Agriculture has developed Swormlure, a highly effective lure for the screwworm fly, and incorporated it into a vaponac-containing food bait. The effectiveness of the lure-bait combination in suppressing screwworm flies has been demonstrated by its use in concert with sterile fly releases in the recent highly successful eradication of the screwworm fly from the island of Curacao. Since then, both the Swormlure composition and the lure-bait combination have been improved.

Hercon proposes to assist in the development of a formulation or formulations to improve further the efficacy of the lure-bait combination by incorporating controlled-release technology into the latest version of this device, now a Swormlure-containing pellet that can be efficiently distributed by aircraft. In the system proposed by Hercon, the pellet will be redesigned with the Swormlure in a multilayer polymeric dispenser which will be joined to the food bait as an integral unit. By this means, Hercon expects to increase the attractiveness (and therefore the kill of the fly) from 3 to 4 days to ca. 14 days. Inclusion of the Swormlure chemicals inside the dispenser will also forestall their premature degradation, particularly of the less stable ingredients.

Hercon will prepare all samples for testing by USDA, develop methods for chemical analysis of Swormlure in vapor and plastic, and carry out analyses of the formulations. Hercon will design and fabricate the new pellets embodying the controlled-release feature. Hercon will also prepare 200 lb. lots of the best designs for field testing by USDA. USDA will carry out all the biological evaluations. At all stages of the project, Hercon will cooperate closely with USDA's Contract Officer's Representative.

The various applications of the Hercon technology described in the

proposal attest to the versatility of the Hercon dispensing system and to the innovative ability of the Hercon Division. Hercon believes that it has the expertise, staff, management and facilities to carry out the proposed project efficiently and economically. ,

I. INTRODUCTION AND OBJECTIVES

The development and application of chemical screwworm fly attractants by the USDA in monitoring and combating the screwworm fly have been documented in a series of publications dating from 1976 (1-13).

The original screwworm fly lure, "Swormlure", was quickly improved, and tests showed that the new product, called Swormlure-2, was at least as attractive as decomposing liver, the previous standard. Results with Swormlure-2 were reliable enough to use it in traps for detecting and monitoring populations of the screwworm fly.

The convenience of a readily available, all-chemical attractant mixture led next to the development of a novel bait-toxicant system (which used small cylindrical bait dispensers) for suppression of the screwworm fly. The system labeled Screwworm Adult Suppression System (SWASS) was tested in 1977 on the island of Curacao where deployment of the SWASS from aircraft and ground over a 15-week period decreased the screwworm population to a low level. At this point (May 1977), sterile flies released periodically suppressed the remaining feral population to insignificant levels in 3-4 weeks. The island was declared free of the screwworm fly in October 1977 after 3 months had passed with no infested animals being found.

Subsequently, a new pelletized formulation of SWASS containing Swormlure-2 was developed, tested, and found highly effective. The advantages of the pellets are that they can be mass produced, and, being small in size, they can be dispensed from aircraft with greater ease and in greater numbers than is possible with the bulky cylindrical traps.

As a further development, a modified formulation, Swormlure-4, has been reported to be more effective than Swormlure-2 in both wind-oriented traps and in pellets.

Unfortunately, the pelleted SWASS loses most of its attraction in 3-4 days, and in regions where "failures" have been observed, there was much less air movement than in South Texas where the pellets had performed well. Furthermore, vapona, the toxicant in the SWASS pellet, has a half life of only 24-48 hours.

The objective of this proposal is to overcome these difficulties, and to increase the effectiveness of the pellets. Toward these ends, three suggestions have been made:

- 1) Use a smaller pellet or wafer (1 gram instead of 3.3 grams).
- 2) Distribute more pellets per square mile (which should make air movement less critical).
- 3) Extend the duration of effectiveness of the pellets to at least 14 days through the use of controlled-release technology.

Hercon Division proposes to work along the lines stated above. It believes its scientists and technical personnel can engineer as well as manufacture a product that will achieve USDA's requirements for a Swormlure pellet more effective and longer lasting than USDA's present pellets. Further, Hercon can do the job most efficiently because of its considerable experience in controlled-release technology, notably in the controlled-release of insect pheromones, insecticides, fragrances, air fresheners, and many other chemicals. Hercon has the chemists, engineers and technical personnel skilled in solving controlled-release type problems, and it has the laboratories and specialized equipment needed to move a product from prototype to full-scale production in minimum time.

II. THE HERCON® CONTROLLED RELEASE DELIVERY SYSTEM

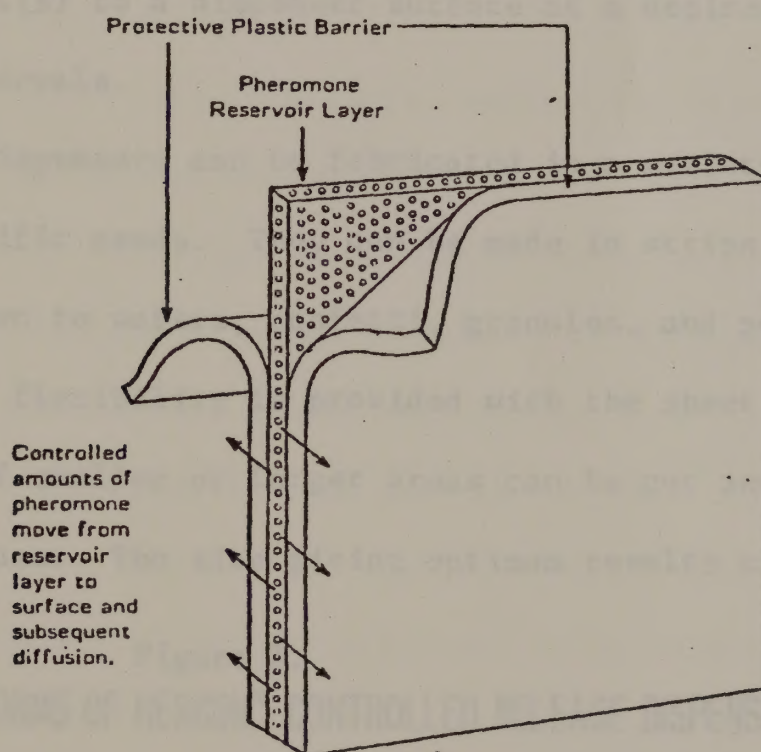
The Hercon delivery system is basically a multi-layer polymeric dispenser in sheet form, which consists of a reservoir layer containing the

active chemical(s) sealed between outer layers. The active chemical gradually diffuses out from the inner layer through one or more of the outer layers to the surface of the dispenser, where it volatilizes into the atmosphere or renders the surface biologically or chemically active.

Figure 1 is a schematic representation of a typical Hercon dispenser of pheromones or other insect attractants.

Figure 1.

THE HERCON® CONTROLLED RELEASE DISPENSER



Hercon Division
HEALTH-CHEM CORPORATION
 1107 Broadway, New York, N.Y. 10010
 212/691 7550

The emission rate and the duration of emission of the active chemicals can be controlled by adjusting one or more of the following parameters:

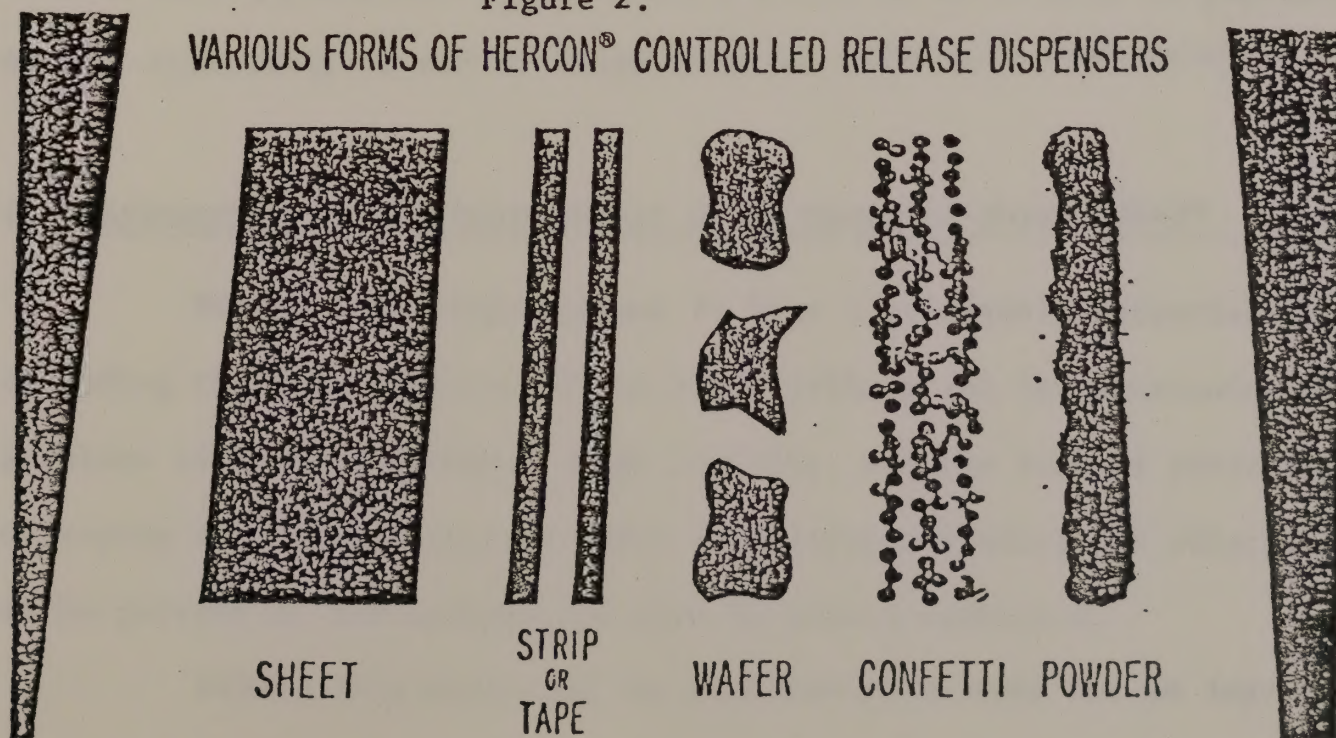
- 1) The concentration of attractant chemical(s) in the reservoir (inner) layer, which may vary from 0.5 to 40% by weight, affects emission rate and capacity of dispenser.
- 2) The thickness of the plastic outer layers (which regulates rate of emission).
- 3) The thickness of the reservoir layer (regulates capacity).
- 4) The plastic used (also affects emission rate).

Thus, it is possible to program the Hercon dispenser to deliver the active chemical(s) to a dispenser surface at a desired rate and for sustained time intervals.

Hercon dispensers can be fabricated in a variety of shapes and sizes to meet specific needs. They can be made in strips or sheets up to 60 inches wide, down to wafers, confetti, granules, and powders. See Figure 2. Further flexibility is provided with the sheet material from which dispensers of smaller or larger areas can be cut and tested at the sites of intended use. The size giving optimum results can then be chosen for use.

Figure 2.

VARIOUS FORMS OF HERCON® CONTROLLED RELEASE DISPENSERS



9

Most important in many applications is the built-in protective features of the dispensers, which make them useable with unstable chemicals and under adverse conditions. These features are derived from the location of the bulk of the active ingredients within the dispenser where it is protected from outside degradative forces; i.e., only a small fraction of the active chemical in the dispenser is on the outer surface at any given time, and the chemical is constantly being replaced as it volatilizes or is used up. For example, such notoriously unstable compounds as aldehydes continue to function effectively in Hercon's dispenser long after other-type dispensers cease to be operative.

Finally, with toxic chemicals, because the major part of the active ingredient is located within the dispenser, very little of a toxic material is available to do damage to humans, pets, or wildlife; yet there is enough chemical to control small pests such as insects. This built-in safety feature is helping solve some very difficult problems relating to control of insects in critical areas such as the home, hotels, restaurants, food-processing plants, and storage depots. This feature could also be useful when application of Swormlure pellets is to be made in populated areas, especially if use of longer-lasting pellets is contemplated.

III. APPROACHES TO THE DEVELOPMENT OF AN IMPROVED SWASS PELLET

Hercon technology appears to have considerable potential for extending the effectiveness of the SWASS pellets and for overcoming the problems of low air movement, high humidity, and the lack of persistence of vaponas in tropical regions where increasingly eradication efforts are to be pursued as the infestation line is pushed southward.

Before this potential is discussed, the need for an improved

SWASS pellet should be placed in proper perspective.

Our understanding of the current strategy for eradication of the screwworm fly is that 3.3-gram pellets are distributed at the rate of 138 per square mile twice a week for 3 weeks and then the sterile flies are released into the treated areas to complete the job. It is apparent that the more effective the pellets are in suppressing fly populations, the quicker and more certain are the prospects for eradication of the fly in any given area treated with a given level of sterile fly releases. Further, since area-wise the operation is enormous, small saving in any part of the eradication procedure can result in considerable savings in the overall cost of the operation.

Potential savings in operational costs may be realized in the following categories:

- 1) Cost of pellet raw materials
- 2) Cost of fabricating pellets
- 3) Cost of distributing pellets (generally by aircraft)
- 4) Cost of rearing sterile flies
- 5) Cost of distributing sterile flies
- 6) Cost of monitoring the flies in the field

Although not listed above, the efficiency of the pellets themselves in killing screwworm flies in the field is a most important consideration. Increased efficiency of the pellets can exhibit itself in terms of greater duration of effectiveness, which would reduce the number of pellet applications required and therefore the cost of distribution of the pellets. Greater efficiency of the pellets can also be realized in terms of increased attraction (and killing power) of the pellets, which could result in either a shorter duration of pellet treatment being required (e.g. 2 weeks instead

of 3 weeks) or in lower population levels of residual flies than is now obtained after pellet treatment, thereby reducing the time required for native fly eradication by sterile flies (and incidentally making eradication more certain). Needless to state, such increased efficacy of the pellets could provide substantial savings in the cost of pellet distribution, cost of rearing and distributing sterile flies (not as many needed for a given area), and even in cost of monitoring native fly populations owing to the more rapid eradication of the flies than would otherwise be realized.

Hercon expects to achieve increased efficiency in pellet performance through the use of its controlled-release technology, specifically by extending duration of pellet effectiveness, increasing pellet effectiveness in killing the screwworm fly, and by redesigning the pellet.

The proposed new pellet would combine the following elements into an integral unit, capable of being ejected rapidly from aircraft:

- 1) 3-layer plastic laminate that will dispense the more volatile ingredients of Swormlure (sec. and isobutyl alcohols, dimethyl disulfide and probably acetic acid).
- 2) another laminate to dispense the remaining ingredients of Swormlure if these ingredients cannot be combined with those in the laminate of 1).
- 3) poison food bait (dried blood, sugar, corn cob grits, wax, vaponal). Components or groups of components may be separate or combined. Formulations will incorporate Hercon's slow-release vaponal dispenser to prolong the effectiveness of the toxicant.
- 4) the geometry of the dispenser to be such that exposure of 1), 2), and 3) are assured.

The reason the new pellet design is needed is that the present SWASS pellet probably does not emit the chemical vapor composition required to attract screwworm flies for more than a short time interval.

The change in vapor composition with time occurs because of the great difference in vapor pressure of the Swormlure ingredients; i.e., the more volatile ingredients boil off quickly, leaving a vapor that is no longer attractive to the screwworm fly. With the Hercon dispenser, change in the vapor composition will be much more gradual because emission from it is based largely on diffusion (rate controlling step) rather than mainly on compound volatility. Thus, with Swormlure in the laminate(s) and separate from the food bait, and the composition of the vapor emitted being reasonably constant, the vapor should be attractive for far greater periods. The constancy of the vapor composition should also result in a more attractive vapor and therefore an increase in the number of flies killed per unit of time. It is our belief that a 4-fold increase in efficiency of a pellet in terms of fly kill is achievable based on duration of effectiveness being extended to 14 days.

The advantage of having the chemicals protected by sealing them within the dispenser should not be overlooked. Phenol, p-cresol, and indole (ingredients of Swormlure) are known to be unstable when exposed to air, and dimethyl disulfide is subject to oxidation. It is not unreasonable to conjecture that the observed failures of the presently used SWASS pellet

could be due in part to a build-up of repellency from products transformed from one or more of the Swormlure ingredients. (This type of occurrence is well known with pheromones; e.g., the sex pheromones of the European corn borer and oriental fruit moth are acetates, which lose attraction when as little as 10-15% of the pheromone is deacetylated, i.e., hydrolyzed.) Sealed within the plastic of the Hercon dispenser, the Swormlure ingredients will be protected from deleterious effects of light, air, humidity, and other climatic factors. The chemicals become vulnerable to outside degradative effects only upon reaching the dispenser surface, but these effects are very small because the chemicals quickly volatilize.

We also suggest the possibility of having the pellet stuck to the surface of foliage instead of falling under it. The pellet can be designed to do this.

IV. IMPLEMENTATION OF PROPOSAL

IV A. Outline of Proposal

The following steps are contemplated in implementing the proposal.

A. Prepare Hercon dispensers containing Swormlure ingredients and determine rate of emission of the ingredients. From the data obtained, additional Hercon dispensers will be prepared with levels of the ingredients being adjusted until emissions from one to several laminates duplicate the vapor phase composition known to be highly attractive to the fly.

B. The best formulations will be sent to Mexico for side-by-side testing of their efficacy in wind-oriented traps. Efficacy will be based on

intensity of attraction (number of insects caught) and duration of effectiveness (how long insects are caught) versus a Swormlure source of known and reproducible potency. Additional formulations will be prepared and tested depending upon results desired. For example, dispensers with long as well as short durations of effectiveness may be desired.

C. Assuming results are satisfactory, a number of pellets, each of different design, will be fabricated and submitted to USDA for side-by-side tests of efficacy (intensity and duration of activity). The poison food bait will be separate from the Swormlure laminate, but attached thereto in several different ways, depending on what is both practical and effective.

D. A quantity of the best type of pellets will be produced for more extensive tests (in the field) versus the present pellet and perhaps no pellets (control). Before these field tests are completed, trials should be conducted in areas where "failures" were observed in the past to determine if any special conditions exist in these areas that may cause problems. Efforts will then be made to overcome the special conditions that may impede future progress in the program.

Hercon will prepare and supply all experimental formulations for the above studies. Hercon will devise methods for the chemical analyses needed in this work. USDA will supply available methodology and ^{Hercon} will conduct the chemical analyses on the various Swormlure formulations they prepare and those supplied by USDA.

Hercon will look to the USDA to 1) evaluate the activity of the Swormlure formulations as part of this proposal, 2) direct the overall operation of this project, and 3) furnish materials (mainly Swormlure, food bait, and ingredients of both) needed for the project.

Hercon will coordinate its work with USDA's representative, arrange

for full interchange of information developed by frequent communication and by quarterly reports, and cooperate fully to move the project forward. A final report will be issued on completion of the project.

USDA should consider the foregoing as an initial submission of a proposal; i.e., Hercon will welcome from USDA personnel, who are highly expert in matters involving screwworm eradication, any changes that will improve the chances of success of this project, assuming USDA is interested in implementing the proposal.

Work on this proposal is considered research rather than product development.

IV B. Specifics of Proposal

In accordance with the foregoing plan, Hercon proposes that the project be divided into four phases.

Phase 1. Methods development and formulations preparation

Hercon will develop methods for analysis of the 10 ingredients of Swormlure in plastic using gas chromatography. This will include setting up apparatus for recovery and analysis of Swormlure. It is probable that a preliminary separation by solvent partition and at least two gas chromatographic analyses will be required per sample. Satisfactory recovery values with the method will be established by analyzing samples of known content. All samples will be analyzed in duplicate.

With satisfactory methods available, Hercon will analyze the vapors that are emitted from at least two high-quality Swormlure sources (to be furnished by USDA).

Concurrently, Hercon will prepare the following three types of 8"x10" plastic laminated sheets: One will contain Swormlure, the second the 4 most volatile ingredients of Swormlure, and the third the remaining

6 ingredients in Swormlure.

The vapors will be analyzed, and from the data obtained, additional plastic laminated sheets will be prepared with the concentrations of the ingredients altered; the vapors emitted will be determined. Undoubtedly, several sets of sheets will have to be prepared (and vapors analyzed) to arrive at the proper formulation.

Phase 2. Bioassay and formulation preparation

The most promising formulations of Phase 1 will be sent to Mexico for side-by-side testing of their efficacy in wind-oriented traps (or in some other way, like laying the dispenser on a wafer of food bait, if deemed appropriate).

Upon receipt of test results, additional laminated sheets containing Swormlure will be prepared by Hercon and evaluated at Mexico. This interchange will be continued until USDA feels the formulations needed have been optimized.

Although the major initial objective will be a formulation effective for 14 days, formulations effective for longer intervals can also be sought.

Tests will be conducted to determine activity of formulation(s) stored for periods of time in different ways to learn the best means of storage.

Phase 3. Integration of Swormlure dispenser and food bait into pellet

Hercon expects to test at least 6 new pellet designs and will make and send the pellets to the USDA. Among the designs contemplated are the following, assuming a 1-inch-square laminate is used (see Figure 3 for first 4 designs):

- 1) laminate with poison food bait on two of its edges.

2) two 3/16-inch wide strips of poison bait across the laminate, on both sides of the laminate.

3) laminate with 4 holes which contain the poison bait protruding about 1/4" on each side of the laminate.

4) a flat poison wafer (1/2"x1"x3/16") attached to one side of the laminate.

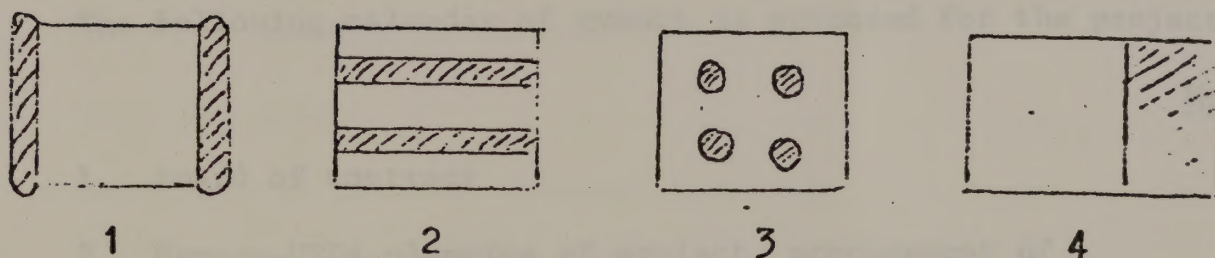


Figure 3. Pellet designs. Shaded area is food bait. Clear area is laminate.

Another possibility is to lay the laminate (perhaps a 1/4"-wide strip) on one or both sides of a poison food wafer.

A further possibility is to spray Hercon flake containing the attractant directly onto a food wafer. Using a stairstep dicer, Hercon can provide uniform particle sizes, from 5/32" to 1/4" squares, for this application. The small squares can be sprayed onto all or part of the poison bait wafers.

The pellets of different design will be bioassayed in Mexico by USDA.

Phase 4. Field Testing of Swormlure pellets

Hercon will prepare 200 lb. of the two or three best formulations for field testing of the types of Swormlure adjudged by USDA to be the

most promising.

Additional quantities will be prepared if desired.

USDA will test the pellets in the field, including areas where "failures" have been observed in the past.

Quarterly reports will be submitted by Hercon describing activities and work planned or to be done. A final report will be issued at the end of the project, which is expected to take 1 year to complete.

IV C. Proposed Calendar of Events

The following calendar of events is proposed for the project:

	<u>Months</u>
1. Award of contract	0
2. Hercon-USDA planning of project, procurement of Swormlure ingredients and Swormlure sources from USDA	0-1
3. Development of chemical methods for Swormlure analysis in plastics	1-3
4. Analysis of vapors from two Swormlure sources, preparation of several sets of laminated test sheets and analysis of their content, USDA bioassay of formulations and selection of most promising formulations	2-6
5. Submittal of first quarterly report	3.5
6. Storage tests on best formulations will be conducted	6-8
7. Submittal of second quarterly report	6.5
8. Preparation by Hercon of newly designed pellets	6.5-7.5

9. Testing by USDA of newly designed pellets and
preparation by Hercon and testing by USDA of
additional designs as appropriate 7.5-9
10. Preparation of 200 lb. batches of pellets by
Hercon for testing by USDA in the field 9-11
11. Submittal of 3rd quarterly report 9.5
12. Submittal of final report 12.5

The foregoing schedule should be considered only as a proposed time-table and one that is flexible. For example, it may not be possible to test formulations throughout the year.

IV D. Cost Elements

Preparation of samples, chemical analyses

5.2 scientist months

Preparation of reports, including final report

0.625 scientist month

Instrumentation and materials

Pilot plant equipment used in production of 200-lb. batches

Materials for bulk lots, etc.

Shipping

Telephone 50 calls estimated

Travel 2 trips (2 days) to Mexico

5 trips Hercon personnel to York, PA

Supervision: Dr. A. F. Kydonieus, Project Director) 1.25 scientist
(To be designated) , Supervisor) month

Dr. Morton Beroza, Chemist Specialist 0.625

scientist

month

V. KEY PERSONNEL

Dr. Agis F. Kydonieus, the Executive Vice President of the Hercon Division, will be the Project Director. Dr. Kydonieus has guided Hercon through a long series of successful applications that utilize controlled-release of chemicals. He is President of the Controlled Release Society, Inc. and a recognized leader in this field and has published extensively on his accomplishments. He is the editor-author of two books on the subject that appeared in the past three years.

Dr. Morton Beroza, formerly of USDA, will assist in planning the project and will be available to advise on the chemical aspects and other problems. He will participate in interpreting the data obtained and in the preparation of the reports to be delivered quarterly and at the end. Dr. Beroza is well known to USDA personnel and is internationally recognized for his research and expertise in the area of pesticide chemistry. He has received numerous awards for his work and has lectured and published widely on pesticide problems.

A supervisor from Hercon will be designated.

Resumes of the foregoing Key Personnel are given in the Appendix.

VI. HERCON EXPERTISE AND FACILITIES

The Hercon Division holds basic patents in controlled-release technology dating back to 1972. Over 12 patents have been issued and more pending in the United States and over 20 other countries. Of Hercon's current 27 registrations granted by the U. S. Environmental Protection Agency, 24 are for controlled-release formulations of insecticides and insect pheromones or attractants. In addition, Hercon also has pending applications, experimental use permits and special local need (SLN)

registrations for over 20 other products, including controlled-release dispensers which release a combination of insect pheromone and insecticide for a "lure-and-kill" application.

Hercon's commercially available EPA-registered products include:

- a) INSECTAPE - A controlled-release dispenser of a residual insecticide, e.g. propoxur (Baygon), chlorpyrifos (Dursban or Lorsban) and diazinon, for control of household pests such as cockroaches, ants and spiders. One INSECTAPE formulation was sold nationally as Johnson Wax' RAID ROACHTAPE. The insecticidal strips are used in residences and in commercial, industrial and institutional establishments.
- b) LURETAPE with DISPARLURE - A controlled-release formulation that dispenses racemic disparlure, the gypsy moth (Lymantria dispar) sex pheromone. This product is manually applied and intended to be used in the disruption of adult moth mating communication and subsequent population suppression. Luretape is sold to local, state and federal agencies involved in gypsy moth management programs. The product is available in perforated roll form.
- c) DISRUPT GM - Another controlled-release formulation of racemic disparlure. DISRUPT GM comes in 1/32" x 3/32" flakes (confetti) and is applied from the air using a custombuilt applicator designed by Hercon and Schweizer Aircraft, the makers of the Ag-Cat. The disparlure flakes have been successfully used for gypsy moth mating disruption in Wisconsin, North Carolina and Virginia. Disrupt is used by the USDA and state agricultural agencies.

d) LURETAPE PLUS - This controlled-release 1" x 1" unit emits the optically active (+) disparlure and is used as lure for gypsy moth traps which are used in monitoring, survey and mass trapping programs. Population suppression results from the failure of adult moth mating; the flying males are lured to their deaths inside traps baited with Luretape Plus. This product is recommended for use as part of an Integrated Pest Management program against gypsy moths, particularly in isolated infestations. Hercon manufactures the Luretape Plus product for USDA-APHIS and state agencies, and also markets it to homeowners via lawn and garden outlets, hardware stores, mass merchandisers and discount stores as part of the Hercon LURE N KILL Gypsy Moth trap package.

e) VAPORTAPE - This is a controlled-release strip which dispenses the insecticide dichlorvos (DDVP or Vapona) which is the toxicant used to kill insects caught in Hercon's LURE N KILL Traps.

f) DISRUPT PBW - This controlled-release confetti product emits gossyplure, the pink bollworm (Pectinophora gossypiella) sex pheromone and is aerially applied to prevent the adult moths from mating and causing damage to cotton in California and Arizona and parts of Mexico. This product has been commercially available since 1981. (Hercon is also expecting registration for a pink bollworm control product which is in confetti form (for aerial application) and which will release the pink bollworm pheromone and a pyrethroid from the same dispenser.)

g) DISRUPT APM - This aerially applied confetti product releases the pheromone for the artichoke plume moth (Platyptilia carduidactyla). This product has been commercially available since 1981 and is now used in artichoke ranches in California.

h) LURETAPE with GRANDLURE - This 1" x 1" dispenser releases the sex and aggregation pheromone of the boll weevil, Anthonomus grandis. These dispensers are used as lures in boll weevil traps which are used for monitoring programs in the United States and mass trapping programs in Central America.

Hercon also has other EPA-registered, controlled-release pheromone dispensers for population suppression of western pineshoot borer, Eupoecilia ambiguella; elm bark beetle, Scolytus multistriatus; Japanese beetle, Popillia japonica; and bagworm, Thyridopteryx ephemeraeformis. Experimental use permits have been issued for products against the peachtree borer, Synanthedon exitiosa; tobacco budworm, Heliothis virescens; and cotton bollworm or corn earworm, Heliothis zea.

Hercon has invested over \$3,000,000 in the research and development of its controlled-release technology against agricultural, lawn and garden and household pests. The research programs are conducted by a team of highly trained and experienced entomologists and chemists who work with federal researchers, university scientists and private industry technical fieldmen in evaluating new products or novel applications of standard pesticides.

In addition to its New York City headquarters, which contains a development laboratory, Hercon has also established a plant in York, Pennsylvania, which is equipped with specially engineered machinery for the high volume production of Hercon multilayered polymeric products. A

quality control section has a fully equipped laboratory with two gas chromatographs available for analytical purposes.

Hercon proposes to make available for the screwworm project its skilled technical personnel, its laboratory, its pilot plant, and manufacturing facilities for development of a successful product.

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ESTIMATED COSTS OF SCREWORM PROJECT (PROPOSED)

Preparation of samples, chemical analyses	
832 hours at \$30/hour	24,960
Preparation of reports including final report	
100 hours at \$30/hour	3,000
Supervision Dr. A. F. Kydonieus, Project Director	
Project Supervisor (to be designated)	
200 hours at av. \$25/hour	5,000
Overhead on above @ 50%	16,480
Instrumentation and materials	2,000
Pilot plant equipment for sample preparation	
and production of 50-lb. batches	4,000
Materials for bulk lots, etc.	1,000
Shipping	500
Telephone-50 calls at \$6/call	300
Travel-2 trips (2 days) to Mexico or Mission, TX	900
5 trips Hercon personnel from New York to York, PA	750
TOTAL	58,890

HERCON[®]**HERCULITE PRODUCTS, INC.**

1107 BROADWAY, NEW YORK, N.Y. 10010 - PHONE (212) 691-7550

Proposal
to
Screwworm Eradication Program
Animal & Plant Health Inspection Service
and
Screwworm Research, Agriculture Research Service
U. S. Department of Agriculture
Mission, TX 78572

DEVELOPMENT OF SLOW-RELEASE SWORMLURE PELLETS FOR
SCREWORM SUPPRESSION

Submitted by:

Hercon Division
Health-Chem Corporation
1107 Broadway
New York, N. Y. 10010

Contact: Dr. A. F. Kydonieus 212/691-7550
or Dr. M. Beroza 301/593-2103

Information in this proposal is not to be disclosed
except for evaluation. Restriction does not apply
if contract is awarded or if information is
available from another source.

CONTENTS

Summary

- I. Introduction and objectives
- II. The Hercon® Controlled Release Delivery System
- III. Approaches to the Development of an Improved Swormlure Pellet
- IV. Implementation of Proposal
 - A. Outline of proposal
 - B. Specifics of proposal
 - C. Proposed calendar of events
 - D. Cost elements
- V. Key Personnel
- VI. Hercon Expertise and Facilities
- VII. References

Appendix

- Resumes of Key Personnel
- Publications

SUMMARY

The U. S. Department of Agriculture has developed Swormlure, a highly effective lure for the screwworm fly, and incorporated it into a vapona-containing food bait. The effectiveness of the lure-bait combination in suppressing screwworm flies has been demonstrated by its use in concert with sterile fly releases in the recent highly successful eradication of the screwworm fly from the island of Curacao. Since then, both the Swormlure composition and the lure-bait combination have been improved.

Hercon proposes to assist in the development of a formulation or formulations to improve further the efficacy of the lure-bait combination by incorporating controlled-release technology into the latest version of this device, now a Swormlure-containing pellet that can be efficiently distributed by aircraft. In the system proposed by Hercon, the pellet will be redesigned with the Swormlure in a multilayer polymeric dispenser which will be joined to the food bait as an integral unit. By this means, Hercon expects to increase the attractiveness (and therefore the kill of the fly) from 1 to 2 days to 4 to 7 days. Inclusion of the Swormlure chemicals inside the dispenser will also forestall their premature degradation, particularly of the less stable ingredients.

Hercon will prepare all samples for testing by USDA, develop methods for chemical analysis of Swormlure in vapor and plastic, and carry out analyses of the formulations. Hercon will design and fabricate the new pellets embodying the controlled-release feature. Hercon will also prepare 50-lb. lots of the best designs for field testing by USDA. USDA will carry out all the biological evaluations. At all stages of the project, Hercon will cooperate closely with USDA's Contract Officer's Representative.

The various applications of the Hercon technology described in the

proposal attest to the versatility of the Hercon dispensing system and to the innovative ability of the Hercon Division. Hercon believes that it has the expertise, staff, management and facilities to carry out the proposed project efficiently and economically.

I. INTRODUCTION AND OBJECTIVES

The development and application of chemical screwworm fly attractants by the USDA in monitoring and combating the screwworm fly have been documented in a series of publications dating from 1976 (1-13).

The original screwworm fly lure, "Swormlure", was quickly improved, and tests showed that the new product, called Swormlure-2, was at least as attractive as decomposing liver, the previous standard. Results with Swormlure-2 were reliable enough to use it in traps for detecting and monitoring populations of the screwworm fly.

The convenience of a readily available, all-chemical attractant mixture led next to the development of a novel bait-toxicant system (which used small cylindrical traps) for suppression of the screwworm fly. The system was tested in 1977 on the island of Curacao where deployment of the traps from aircraft and ground over a 15-week period decreased the screwworm population to a low level. At this point (May 1977), sterile flies released periodically suppressed the remaining feral population to insignificant levels in 3-4 weeks. The island was declared free of the screwworm fly in October 1977 after 3 months had passed with no infested animals being found.

Subsequently, a new pelletized formulation containing Swormlure-2 was developed, tested, and found highly effective. The advantages of the pellets are that they can be mass produced, and, being small in size, they can be dispensed from aircraft with greater ease and in greater numbers than is possible with the bulky cylindrical traps.

As a further development, a modified formulation, Swormlure-4, has been reported to be more effective than Swormlure-2 in both wind-oriented traps and in pellets.

Unfortunately, the pelleted Swormlure loses most of its attraction in 24-48 hours, and in regions where "failures" have been observed, there was much less air movement than in South Texas where the pellets had performed well.

The objective of this proposal is to overcome this difficulty, and to increase the effectiveness of the pellets. Toward these ends, three suggestions have been made:

- 1) Use a smaller pellet or wafer (1 gram instead of 3.3 grams).
- 2) Distribute more pellets per square mile (which should make air movement less critical).
- 3) Extend the duration of effectiveness of the pellets to at least 3 to 4 days through the use of controlled-release technology.

Hercon Division proposes to work along the lines stated above. It believes its scientists and technical personnel can engineer as well as manufacture a product that will achieve USDA's requirements for a Swormlure pellet more effective and longer lasting than USDA's present pellets. Further, Hercon can do the job most efficiently because of its considerable experience in controlled-release technology, notably in the controlled-release of insect pheromones, insecticides, fragrances, air fresheners, and many other chemicals. Hercon has the chemists, engineers and technical personnel skilled in solving controlled-release type problems, and it has the laboratories and specialized equipment needed to move a product from prototype to full-scale production in minimum time.

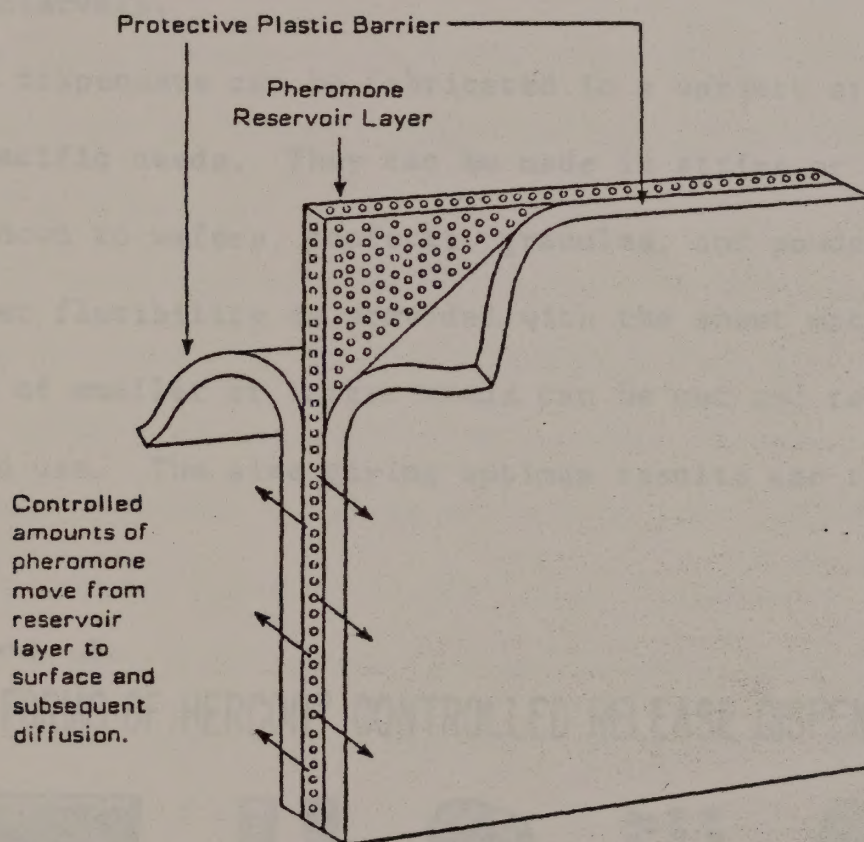
II. THE HERCON® CONTROLLED RELEASE DELIVERY SYSTEM

The Hercon delivery system is basically a multi-layer polymeric dispenser in sheet form, which consists of a reservoir layer containing the

active chemical(s) sealed between outer layers. The active chemical gradually diffuses out from the inner layer through one or more of the outer layers to the surface of the dispenser, where it volatilizes into the atmosphere or renders the surface biologically or chemically active.

Figure 1 is a schematic representation of a typical Hercon dispenser of pheromones or other insect attractants.

Fig. 1 THE HERCON® CONTROLLED RELEASE DISPENSER



Hercon Division
HEALTH-CHEM CORPORATION
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212/691-7550

The emission rate and the duration of emission of the active chemicals can be controlled by adjusting one or more of the following parameters:

- 1) The concentration of attractant chemical(s) in the reservoir (inner) layer, which may vary from 0.5 to 40% by weight, affects emission rate and capacity of dispenser.

2) The thickness of the plastic outer layers (which regulates rate of emission).

3) The thickness of the reservoir layer (regulates capacity).

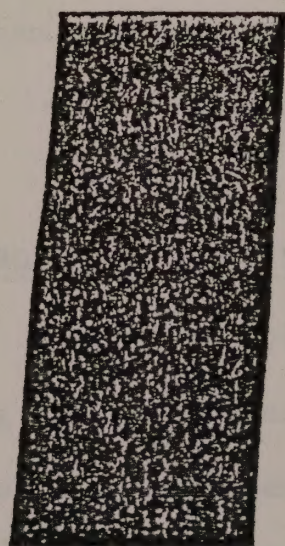
4) The plastic used (also affects emission rate).

Thus, it is possible to program the Hercon dispenser to deliver the active chemical(s) to a dispenser surface at a desired rate and for sustained time intervals.

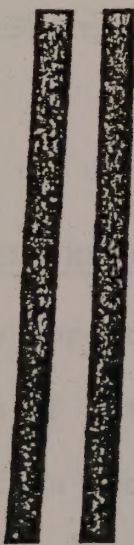
Hercon dispensers can be fabricated in a variety of shapes and sizes to meet specific needs. They can be made in strips or sheets up to 60 inches wide, down to wafers, confetti, granules, and powders. See Figure 2. Further flexibility is provided with the sheet material from which dispensers of smaller or larger areas can be cut and tested at the sites of intended use. The size giving optimum results can then be chosen for use.

Figure 2.

VARIOUS FORMS OF HERCON® CONTROLLED RELEASE DISPENSERS



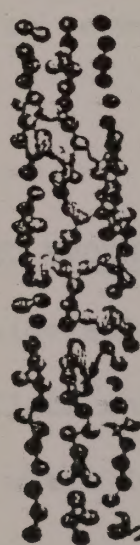
SHEET



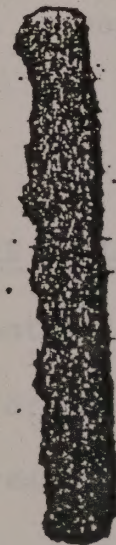
STRIP
OR
TAPE



WAFER



CONFETTI



POWDER

Most important in many applications is the built-in protective features of the dispensers, which make them useable with unstable chemicals and under adverse conditions. These features are derived from the location of the bulk of the active ingredients within the dispenser where it is protected from outside degradative forces; i.e., only a small fraction of the active chemical in the dispenser is on the outer surface at any given time, and the chemical is constantly being replaced as it volatilizes or is used up. For example, such notoriously unstable compounds as aldehydes continue to function effectively in Hercon's dispenser long after other-type dispensers cease to be operative.

Finally, with toxic chemicals, because the major part of the active ingredient is located within the dispenser, very little of a toxic material is available to do damage to humans, pets, or wildlife; yet there is enough chemical to control small pests such as insects. This built-in safety feature is helping solve some very difficult problems relating to control of insects in critical areas such as the home, hotels, restaurants, food-processing plants, and storage depots. This feature could also be useful when application of Swormlure pellets is to be made in populated areas.

III. APPROACHES TO THE DEVELOPMENT OF AN IMPROVED SWORMLURE PELLET

Hercon technology appears to have considerable potential for extending the effectiveness of the Swormlure pellets and for overcoming the problem of low air movement in tropical regions where increasingly eradication efforts are to be pursued as the infestation line is pushed southward.

Before this potential is discussed, the need for an improved

Swormlure pellet should be placed in proper perspective.

Our understanding of the current strategy for eradication of the screwworm fly is that 3.3-gram pellets are distributed at the rate of 138 per square mile twice a week for 3 weeks and then the sterile flies are released into the treated areas to complete the job. It is apparent that the more effective the pellets are in suppressing fly populations, the quicker and more certain are the prospects for eradication of the fly in any given area treated with a given level of sterile fly releases. Further, since area-wise the operation is enormous, small saving in any part of the eradication procedure can result in considerable savings in the overall cost of the operation.

Potential savings in operational costs may be realized in the following categories:

- 1) Cost of pellet raw materials
- 2) Cost of fabricating pellets
- 3) Cost of distributing pellets (generally by aircraft)
- 4) Cost of rearing sterile flies
- 5) Cost of distributing sterile flies
- 6) Cost of monitoring the flies in the field

Although not listed above, the efficiency of the pellets themselves in killing screwworm flies in the field is a most important consideration. Increased efficiency of the pellets can exhibit itself in terms of greater duration of effectiveness, which would reduce the number of pellet applications required and therefore the cost of distribution of the pellets. Greater efficiency of the pellets can also be realized in terms of increased attraction (and killing power) of the pellets, which could result in either a shorter duration of pellet treatment being required (e.g. 2 weeks instead

of 3 weeks) or in lower population levels of residual flies than is now obtained after pellet treatment, thereby reducing the time required for native fly eradication by sterile flies (and incidentally making eradication more certain). Needless to state, such increased efficacy of the pellets could provide substantial savings in the cost of pellet distribution, cost of rearing and distributing sterile flies (not as many needed for a given area), and even in cost of monitoring native fly populations owing to the more rapid eradication of the flies than would otherwise be realized.

Hercon expects to achieve increased efficiency in pellet performance through the use of its controlled-release technology, specifically by extending duration of pellet effectiveness, increasing pellet effectiveness in killing the screwworm fly, and by redesigning the pellet.

The proposed new pellet would combine the following elements into an integral unit, capable of being ejected rapidly from aircraft:

- 1) 3-layer plastic laminate that will dispense the more volatile ingredients of Swormlure (sec. and isobutyl alcohols, dimethyl disulfide and probably acetic acid).
- 2) another laminate to dispense the remaining ingredients of Swormlure if these ingredients cannot be combined with those in the laminate of 1).
- 3) poison food bait (dried blood, sugar, corn cob grits, wax, vaponal).
- 4) the geometry of the dispenser to be such that exposure of 1), 2), and 3) are assured.

The reason the new pellet design is needed is that the present Swormlure pellet probably does not emit the chemical vapor composition required to attract screwworm flies for more than a short time interval.

The change in vapor composition with time occurs because of the great difference in vapor pressure of the Swormlure ingredients; i.e., the more volatile ingredients boil off quickly, leaving a vapor that is no longer attractive to the screwworm fly. With the Hercon dispenser, change in the vapor composition will be much more gradual because emission from it is based largely on diffusion (rate controlling step) rather than mainly on compound volatility. Thus, with Swormlure in the laminate(s) and separate from the food bait, and the composition of the vapor emitted being reasonably constant, the vapor should be attractive for far greater periods. The constancy of the vapor composition should also result in a more attractive vapor and therefore an increase in the number of flies killed per unit of time. It is our belief that a 4-fold increase in efficiency of a pellet in terms of fly kill is achievable based on duration of effectiveness being extended from 1 to 4 days.

We also suggest the possibility of producing a pellet with a duration of effectiveness longer than 4 days; e.g., one effective for 7 days; and then, at an interval before sterile fly release, applying a pellet with a shorter duration of effectiveness; e.g., one effective for 3 or 4 days. Such a possibility appears attainable through the use of the Hercon laminated dispenser. If successful, this possibility would reduce the present number of pellet applications and therefore the cost of application of the pellets.

The advantage of having the chemicals protected by sealing them within the dispenser should not be overlooked. Phenol, p-cresol, and indole (ingredients of Swormlure) are known to be unstable when exposed to air, and dimethyl disulfide is subject to oxidation. It is not unreasonable to conjecture that the observed failures of the presently used Swormlure pellets

could be due in part to a build-up of repellency from products transformed from one or more of the Swormlure ingredients. (This type of occurrence is well known with pheromones; e.g., the sex pheromones of the European corn borer and oriental fruit moth are acetates, which lose attraction when as little as 10-15% of the pheromone^{is} deacetylated, i.e., hydrolyzed.) Sealed within the plastic of the Hercon dispenser, the Swormlure ingredients will be protected from deleterious effects of light, air, humidity, and other climatic factors. The chemicals become vulnerable to outside degradative effects only upon reaching the dispenser surface, but these effects are very small because the chemicals quickly volatilize.

We also suggest the possibility of having the pellet stuck to the surface of foliage instead of falling under it. The pellet can be designed to do this.

IV. IMPLEMENTATION OF PROPOSAL

IV A. Outline of Proposal

The following steps are contemplated in implementing the proposal.

A. Analyze emission of the chemicals from a Swormlure source or sources known to be highly attractive to the screwworm fly to determine the composition of the vapor that is highly attractive to the fly.

B. Prepare Hercon dispensers containing Swormlure ingredients and determine rate of emission of the ingredients. From the data obtained, additional Hercon dispensers will be prepared with levels of the ingredients being adjusted until emissions from one to several laminates duplicate the vapor phase composition known to be highly attractive to the fly.

C. The best formulations will be sent to Mexico for side-by-side testing of their efficacy in wind-oriented traps. Efficacy will be based on

intensity of attraction (number of insects caught) and duration of effectiveness (how long insects are caught) versus a Swormlure source of known and reproducible potency. Additional formulations will be prepared and tested depending upon results desired. For example, dispensers with long as well as short durations of effectiveness may be desired.

D. Assuming results are satisfactory, a number of pellets, each of different design, will be fabricated and submitted to USDA for side-by-side tests of efficacy (intensity and duration of activity). The poison food bait will be separate from the Swormlure laminate, but attached thereto in several different ways, depending on what is both practical and effective.

E. A quantity of the best type of pellets will be produced for more extensive tests (in the field) versus the present pellet and perhaps no pellets (control). Before these field tests are completed, trials should be conducted in areas where "failures" were observed in the past to determine if any special conditions exist in these areas that may cause problems. Efforts will then be made to overcome the special conditions that may impede future progress in the program.

Hercon will prepare and supply all experimental formulations for the above studies. Hercon will devise methods for all chemical analyses needed in this work and will conduct the chemical analyses on the various Swormlure formulations they prepare and those supplied by USDA.

Hercon will look to the USDA to 1) evaluate the activity of the Swormlure formulations as part of this proposal, 2) direct the overall operation of this project, and 3) furnish materials (mainly Swormlure, food bait, and ingredients of both) needed for the project.

Hercon will coordinate its work with USDA's representative, arrange

for full interchange of information developed by frequent communication and by quarterly reports, and cooperate fully to move the project forward. A final report will be issued on completion of the project.

USDA should consider the foregoing as an initial submission of a proposal; i.e., Hercon will welcome from USDA personnel, who are highly expert in matters involving screwworm eradication, any changes that will improve the chances of success of this project, assuming USDA is interested in implementing the proposal.

IV B. Specifics of Proposal

In accordance with the foregoing plan, Hercon proposes that the project be divided into four phases.

Phase 1. Methods development and formulations preparation

Hercon will develop methods for analysis of the 10 ingredients of Swormlure in vapor and plastic using gas chromatography. This will include setting up apparatus for recovery and analysis of Swormlure vapors. It is probable that a preliminary separation by solvent partition and at least two gas chromatographic analyses will be required per sample. Satisfactory recovery values with the method will be established by analyzing samples of known content. All samples will be analyzed in duplicate (160 hours).

With satisfactory methods available, Hercon will analyze the vapors that are emitted from at least two high-quality Swormlure sources (to be furnished by USDA) (32 hours).

Concurrently, Hercon will prepare the following three types of 8"x10" plastic laminated sheets: One will contain Swormlure, the second the 4 most volatile ingredients of Swormlure, and the third the remaining

6 ingredients in Swormlure (24 hours). The vapors will be analyzed, and from the data obtained, additional plastic laminated sheets will be prepared with the concentrations of the ingredients altered; the vapors emitted will be determined. Undoubtedly, several sets of sheets will have to be prepared (and vapors analyzed) to arrive at the proper formulation. (168 hours)

Phase 2. Bioassay and formulation preparation

The most promising formulations of Phase 1 will be sent to Mexico for side-by-side testing of their efficacy in wind-oriented traps (or in some other way, like laying the dispenser on a wafer of food bait, if deemed appropriate).

Upon receipt of test results, additional laminated sheets containing Swormlure will be prepared by Hercon and evaluated at Mexico. This interchange will be continued until USDA feels the formulations needed have been optimized. (112 hours)

Although the major initial objective will be a formulation effective for 4 days, formulations effective for longer intervals, such as 7 days, can also be sought.

Tests will be conducted to determine activity of formulation(s) stored for periods of time in different ways to learn the best means of storage (72 hours).

Phase 3. Integration of Swormlure dispenser and food bait into pellet

Hercon expects to test at least 6 new pellet designs and will make and send the pellets to the USDA. Among the designs contemplated are the following, assuming a 1-inch-square laminate is used (see Figure 3 for first 4 designs):

- 1) laminate with poison food bait on two of its edges.

2) two 3/16-inch wide strips of poison bait across the laminate, on both sides of the laminate.

3) laminate with 4 holes which contain the poison bait protruding about 1/4" on each side of the laminate.

4) a flat poison wafer (1/2"x1"x3/16") attached to one side of the laminate.

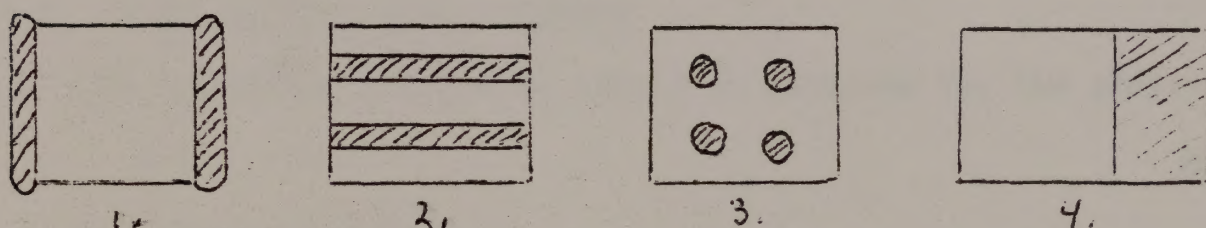


Figure 3. Pellet designs. Shaded area is food bait. Clear area is laminate.

Another possibility is to lay the laminate (perhaps a 1/4"-wide strip) on one or both sides of a poison food wafer.

A further possibility is to spray Hercon flake containing the attractant directly onto a food wafer. Using a stairstep dicer, Hercon can provide uniform particle sizes, from 5/32" to 1/4" squares, for this application. The small squares can be sprayed onto all or part of the poison bait wafers. (Total time 144 hours)

The pellets of different design will be bioassayed in Mexico by USDA.

Phase 4. Field Testing of Swormlure pellets

Hercon will prepare 50 lbs. of the two or three best formulations for field testing of the types of Swormlure adjudged by USDA to be the

most promising. (144 hours)

Additional quantities will be prepared if desired.

USDA will test the pellets in the field, including areas where "failures" have been observed in the past.

Quarterly reports will be submitted by Hercon describing activities and work planned or to be done. A final report will be issued at the end of the project, which is expected to take 1 year to complete (100 hours).

IV C. Proposed Calendar of Events

The following calendar of events is proposed for the project:

	<u>Months</u>
1. Award of contract	0
2. Hercon-USDA planning of project, procurement of Swormlure ingredients and Swormlure sources from USDA	0-1
3. Development of chemical methods for Swormlure analysis in vapor and in plastics	1-3
4. Analysis of vapors from two Swormlure sources, preparation of several sets of laminated test sheets and analysis of their vapor and content, USDA bioassay of formulations and selection of most promising formulations	2-6
5. Submittal of first quarterly report	3.5
6. Storage tests on best formulations will be conducted	6-8
7. Submittal of second quarterly report	6.5
8. Preparation by Hercon of newly designed pellets	6.5-7.5

9. Testing by USDA of newly designed pellets and
preparation by Hercon and testing by USDA of
additional designs as appropriate 7.5-9
10. Preparation of 50-lb. batches of pellets by
Hercon for testing by USDA in the field 9-11
11. Submittal of 3rd quarterly report 9.5
12. Submittal of final report 12.5

The foregoing schedule should be considered only as a proposed time-table and one that is flexible. For example, it may not be possible to test formulations throughout the year.

IV D. Cost Elements

Preparation of samples, chemical analyses

5.2 scientist months

Preparation of reports, including final report

0.625 scientist month

Instrumentation and materials

Pilot plant equipment used in production of 50-lb. batches

Materials for bulk lots, etc.

Shipping

Telephone 50 calls estimated

Travel 2 trips (2 days) to Mexico

5 trips Hercon personnel to York, PA

Supervision: Dr. A. F. Kydonieus, Project Director) 1.25 scientist
(To be designated) , Supervisor) month

Dr. Morton Beroza, Chemist Specialist 0.625

scientist

month

V. KEY PERSONNEL

Dr. Agis F. Kydonieus, the Executive Vice President of the Hercon Division, will be the Project Director. Dr. Kydonieus has guided Hercon through a long series of successful applications that utilize controlled-release of chemicals. He is President of the Controlled Release Society, Inc. and a recognized leader in this field and has published extensively on his accomplishments. He is the editor-author of two books on the subject that appeared in the past three years.

Dr. Morton Beroza, formerly of USDA, will assist in planning the project and will be available to advise on the chemical aspects and other problems. He will participate in interpreting the data obtained and in the preparation of the reports to be delivered quarterly and at the end. Dr. Beroza is well known to USDA personnel and is internationally recognized for his research and expertise in the area of pesticide chemistry. He has received numerous awards for his work and has lectured and published widely on pesticide problems.

A supervisor from Hercon will be designated.

Resumes of the foregoing Key Personnel are given in the Appendix.

VI. HERCON EXPERTISE AND FACILITIES

The Hercon Division holds basic patents in controlled-release technology dating back to 1972. Over 12 patents have been issued and more pending in the United States and over 20 other countries. Of Hercon's current 27 registrations granted by the U. S. Environmental Protection Agency, 24 are for controlled-release formulations of insecticides and insect pheromones or attractants. In addition, Hercon also has pending applications, experimental use permits and special local need (SLN)

registrations for over 20 other products, including controlled-release dispensers which release a combination of insect pheromone and insecticide for a "lure-and-kill" application.

Hercon's commercially available EPA-registered products include:

- a) INSECTAPE - A controlled-release dispenser of a residual insecticide, e.g. propoxur (Baygon), chlorpyrifos (Dursban or Lorsban) and diazinon, for control of household pests such as cockroaches, ants and spiders. One INSECTAPE formulation was sold nationally as Johnson Wax' RAID ROACHTAPE. The insecticidal strips are used in residences and in commercial, industrial and institutional establishments.
- b) LURETAPE with DISPARLURE - A controlled-release formulation that dispenses racemic disparlure, the gypsy moth (Lymantria dispar) sex pheromone. This product is manually applied and intended to be used in the disruption of adult moth mating communication and subsequent population suppression. Luretape is sold to local, state and federal agencies involved in gypsy moth management programs. The product is available in perforated roll form.
- c) DISRUPT GM - Another controlled-release formulation of racemic disparlure. DISRUPT GM comes in 1/32" x 3/32" flakes (confetti) and is applied from the air using a custombuilt applicator designed by Hercon and Schweizer Aircraft, the makers of the Ag-Cat. The disparlure flakes have been successfully used for gypsy moth mating disruption in Wisconsin, North Carolina and Virginia. Disrupt is used by the USDA and state agricultural agencies.

d) LURETAPE PLUS - This controlled-release 1" x 1" unit emits the optically active (+) disparlure and is used as lure for gypsy moth traps which are used in monitoring, survey and mass trapping programs. Population suppression results from the failure of adult moth mating; the flying males are lured to their deaths inside traps baited with Luretape Plus. This product is recommended for use as part of an Integrated Pest Management program against gypsy moths, particularly in isolated infestations. Hercon manufactures the Luretape Plus product for USDA-APHIS and state agencies, and also markets it to homeowners via lawn and garden outlets, hardware stores, mass merchandisers and discount stores as part of the Hercon LURE N KILL Gypsy Moth trap package.

e) VAPORTAPE - This is a controlled-release strip which dispenses the insecticide dichlorvos (DDVP or Vapona) which is the toxicant used to kill insects caught in Hercon's LURE N KILL Traps.

f) DISRUPT PBW - This controlled-release confetti product emits gossyplure, the pink bollworm (Pectinophora gossypiella) sex pheromone and is aerially applied to prevent the adult moths from mating and causing damage to cotton in California and Arizona and parts of Mexico. This product has been commercially available since 1981. (Hercon is also expecting registration for a pink bollworm control product which is in confetti form (for aerial application) and which will release the pink bollworm pheromone and a pyrethroid from the same dispenser.)

g) DISRUPT APM - This aerially applied confetti product releases the pheromone for the artichoke plume moth (Platyptilia carduidactyla). This product has been commercially available since 1981 and is now used in artichoke ranches in California.

h) LURETAPE with GRANDLURE - This 1" x 1" dispenser releases the sex and aggregation pheromone of the boll weevil, Anthonomus grandis. These dispensers are used as lures in boll weevil traps which are used for monitoring programs in the United States and mass trapping programs in Central America.

Hercon also has other EPA-registered, controlled-release pheromone dispensers for population suppression of western pineshoot borer, Eupoecilia ambiguella; elm bark beetle, Scolytus multistriatus; Japanese beetle, Popillia japonica; and bagworm, Thyridopteryx ephemeraeformis. Experimental use permits have been issued for products against the peachtree borer, Synanthedon exitiosa; tobacco budworm, Heliothis virescens; and cotton bollworm or corn earworm, Heliothis zea.

Hercon has invested over \$3,000,000 in the research and development of its controlled-release technology against agricultural, lawn and garden and household pests. The research programs are conducted by a team of highly trained and experienced entomologists and chemists who work with federal researchers, university scientists and private industry technical fieldmen in evaluating new products or novel applications of standard pesticides.

In addition to its New York City headquarters, which contains a development laboratory, Hercon has also established a plant in York, Pennsylvania, which is equipped with specially engineered machinery for the high volume production of Hercon multilayered polymeric products. A

quality control section has a fully equipped laboratory with two gas chromatographs available for analytical purposes.

Hercon proposes to make available for the screwworm project its skilled technical personnel, its laboratory, its pilot plant, and manufacturing facilities for development of a successful product.

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M. Beroza & Associates, Inc.

CONSULTANTS

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Phone (301) 593-2103

November 16, 1982

Dr. O. H. Graham
USDA-ARS Screwworm Research
P. O. Box 986
Mission, TX 78572

Dear Hugh:

As I mentioned in our conversations, I have read the materials you sent me and am very favorably impressed by the SWASS approach. I feel confident that a slow-release formulation can be developed to extend the duration of swormlure attraction from one to perhaps four or five days, which I believe is your target.

The major effort I would propose would involve design and engineering of a pellet-lure dispenser combination that can be ejected from aircraft plus chemical work to check emission rates of the lure chemicals from the dispensers.

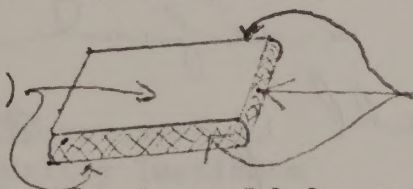
Basically, the proposed dispenser would combine the following elements:

- a. 3-layer plastic laminate to dispense the sec. and isobutyl alcohols and the dimethyldisulfide
- b. another laminate to dispense the remaining ingredients of swormlure (if it can't be combined with item a.).
- c. poison bait (food) pellet
- d. the geometry of the dispenser to be such that exposure of a., b. and c. are assured.

By way of example, the following diagram shows a possible pellet:

poison bait

(available top and bottom)



Swormlure dispensed
from edges

The poison bait on the top surface would be available to the fly. The Swormlure can volatilize from the edges regardless of which side the pellet (rectangular) lands on. The poison bait can be a wafer (rather thin) to save on material.

Another possibility is the usual flat 3-layer plastic dispenser of the lure coated with the poison partially on its surfaces. The dispenser design will depend to some extent on the plastic to be used and the qualities of the poison bait.

I believe this work can be conducted expeditiously by Hercon Products at their York, PA factory where they have chemists, chemical instrumentation, engineers, and production facilities on hand. Assuming this is considered, such an effort would require the close cooperation of the Mission lab, APHIS, and Hercon.

I trust the foregoing is helpful.

Sincerely,

With best regards,

Morton

Morton Beroza

12/17/82

Mart -

my apologies for not having replied more formally but have been in Mexico most of the time since this letter arrived - you have some very interesting ideas -

Dr. Jim Macksley, who is working on attractants in Mexico, will be in Woodbine, Maryland on leave later this month & will call you before leaving Maryland - hope you can see him & discuss both your ideas & his research. He can also travel to NYC if it would be useful - He will probably call you ~~at~~ about Jan 3 -

Happy Holiday Season,

Hugh

September 23, 1982

SUBJECT: Formulation of Swormlure

TO: The Files

On September 21 I received a call from Dr. Jim Mackley, ARS, Tuxtla Gutierrez, Mexico, to discuss the formulation of a screwworm attractant. Under the conditions prevailing in Central Mexico, Swormlure-2 formulations and SWASS formulations lose their attractancy rapidly. The modified formulation, Swormlure 4, was being used and, in this modification, quantities of the more volatile components were increased.

The pellets are scattered by air and it is considered that a smaller pellet than those currently used might be advantageous. The release rate should be such that activity is maintained for 3-4 days.

The question of suitable controlled release techniques was raised. We conducted some research on this topic several years ago and the Laboratory evaluated several controlled release devices before the wax formulation of swormlure was adopted. However, some controlled release techniques might be adapted to the solution of this problem and I will attempt to identify candidates for study.

The attached copy of a memorandum from Dr. O. H. Graham indicates that the formulation problem has been brought to the attention of the Program Staff.

/S/ Jack R. Plimmer

JACK R. PLIMMER, Chief
Organic Chemical Synthesis Laboratory
Agricultural Environmental Quality Institute

cc:

B. A. Leonhardt

W. Klassen

J. Mackley

R. Bram

H. Brown

S. H. Graham

